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THE WEATHER AND CIRCULATION OF JANUARY 1970

Record Cold in the Eastern Third of the Nation and Record Rainfall in the Pacific Northwest

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1. MEAN CIRCULATION

An extremely vigorous, expanded 700-mb circulation prevailed over the western part of the Northern Hemisphere during January 1970, with the strongest westerlies averaging 17 m sec^{-1} at 35° N., which was nearly 10 m sec^{-1} above the normal for that latitude. Troughs and ridges at middle latitudes were characterized by moderate amplitude. There were three principal cyclonic centers of action in the Northern Hemisphere, located near Novaya Zemlya, between Kamchatka and the Aleutians, and over eastern Canada (fig. 1). The latter was split into two cells. A pronounced high-latitude blocking center with heights 180 m above normal was located over the Arctic Ocean north of the Bering Strait, while a blocking ridge just west of Norway produced heights 110 m above normal (figs. 1 and 2).

The broad cyclonic flow over the oceans at midlatitudes was associated with anomaly centers of 100 and 170 m below normal over the Pacific and Atlantic, respectively (fig. 2). The Atlantic center was over two and one-half standard deviations below normal. Frequent and relatively deep surface cyclones crossed these oceanic areas on tracks south of normal. Episodes of damaging surf in the Hawaiian Islands, which had begun in December, continued into January.

The mean 700-mb jet stream was displaced south of the normal January position, particularly over the two oceans (fig. 3). Peak mean speeds were more than 10 m sec^{-1} above normal over the Pacific and in excess of 15 m sec^{-1} above normal over the eastern Atlantic. Monthly mean wind speeds were below normal over the northern sectors of the oceans.

The greatest change in circulation between December and January occurred over the central Atlantic where an unusually strong ridge (Posey 1970) gave way to fast westerlies and broad cyclonic flow. The departures from the respective normals of the 700-mb height fell by as much as 320 m between the 2 mo (fig. 4). Heights increased with respect to normal at high latitudes, particularly over

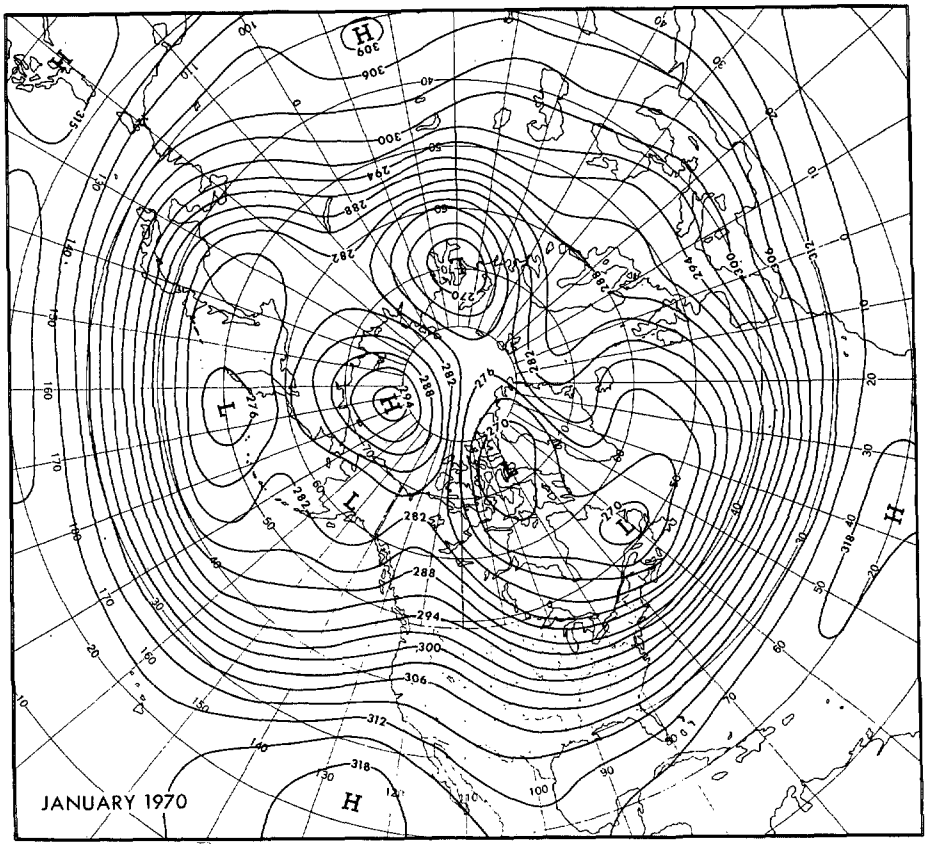


FIGURE 1.—Mean 700-mb contours (decameters) for January 1970.

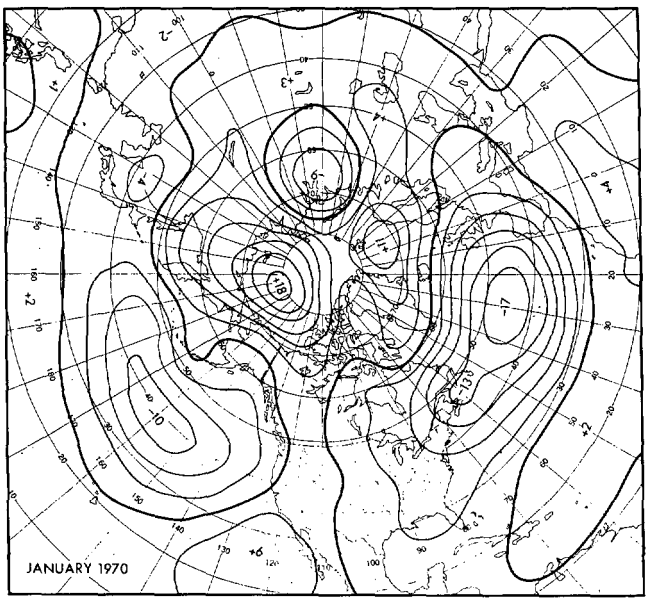


FIGURE 2.—Departure from normal of mean 700-mb height (decameters) for January 1970.

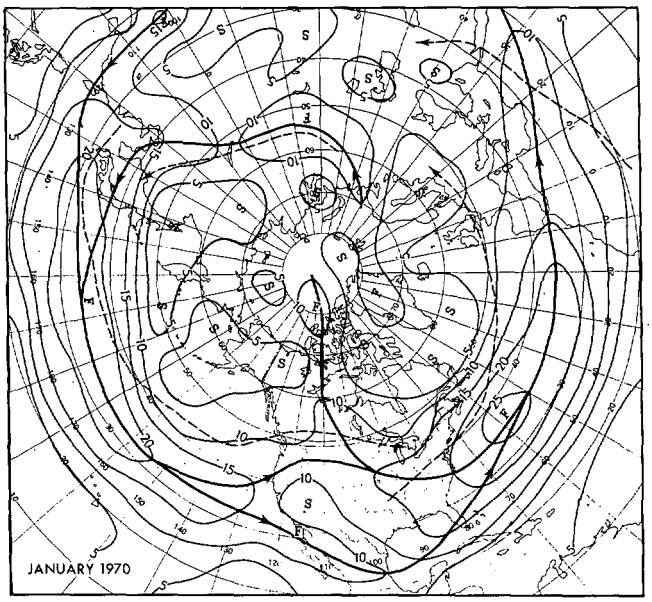


FIGURE 3.—Mean 700-mb geostrophic wind speed (meters per second) for January 1970. Heavy solid lines show axes of maximum wind speed, and dashed lines indicate the January normal. Centers of relative maximum and minimum wind speed are labeled F and S, respectively.

northeastern Siberia and the Aleutians. The changes in the Pacific reflected increasing high-latitude blocking and southward movement of the jet stream and associated prevailing cyclone tracks.

The broad-scale intramouth variability of the circulation during January 1970 is shown in figure 5. The maximum anomalous extent of the expanded circumpolar circulation was evidently reached in the first half of the month. Extensive areas of height falls with maximum values of more than 200 m prevailed over the Arctic Ocean, the North Pacific, most of Canada, and the northwest Atlantic. Westerly flow at midlatitudes increased over the entire western part of the Northern Hemisphere during the latter half of the month.

It is of interest to examine the mean sea surface temperature anomalies during the month of December 1969. Large areas of water more than 2°F above normal were located north of Hawaii and south of Newfoundland (fig. 6). The distribution of temperature anomaly in the Pacific was very similar to that prevailing in the same month just a year previous (compare with fig. 5A of Wagner 1969). Vigorous cyclonic activity prevailed over the central and eastern Pacific in both years, although the exact locations of maximum activity and downstream repercussions for the U.S. mainland were quite different in the 2 yr due to large differences in circulation elsewhere.

It is likely that the intense deepening of many of the storms moving into the Atlantic during January 1970 was contributed to by the destabilizing and potential energy-generating effects of the warm pool south of Newfoundland. This anomalously warm water had been generated by the unusually strong southerly ocean surface transport and anticyclonic conditions prevailing in that area for the preceding 2 mo (Green 1970, Posey 1970). It has been shown by Namias (1969) that season-to-season interactions of this type have occurred frequently in the last decade over the Pacific Ocean.

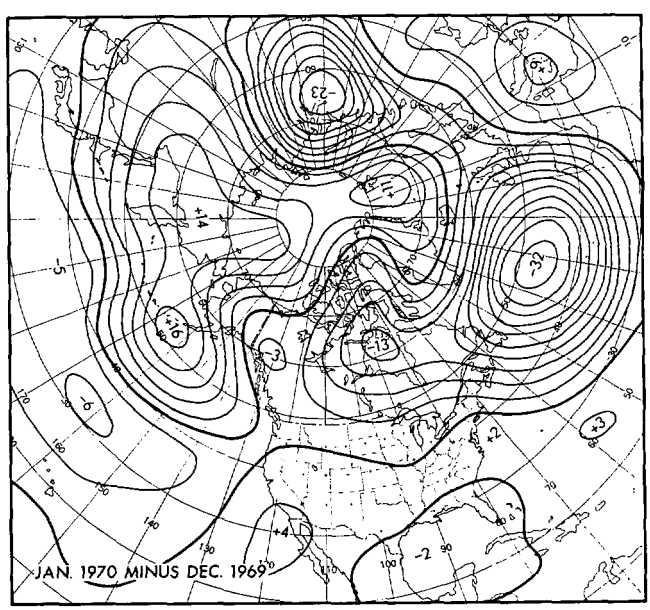


FIGURE 4.—Change in monthly mean 700-mb height anomaly (decameters) between December 1969 and January 1970.

2. TEMPERATURE

Extreme and persistent cold was observed over the eastern half of the Nation during January 1970 (fig. 7A). The pattern of monthly mean temperature anomaly was similar to that of the previous month, although negative anomalies were of greater magnitude (compare fig. 7A with fig. 5 of Posey 1970). Northerly anomalous flow prevailed over the Nation east of the Rockies in the region of low temperatures. Although the height anomaly pattern was weak in the West, that region lay just downstream from an area of anomalously strong southwesterly

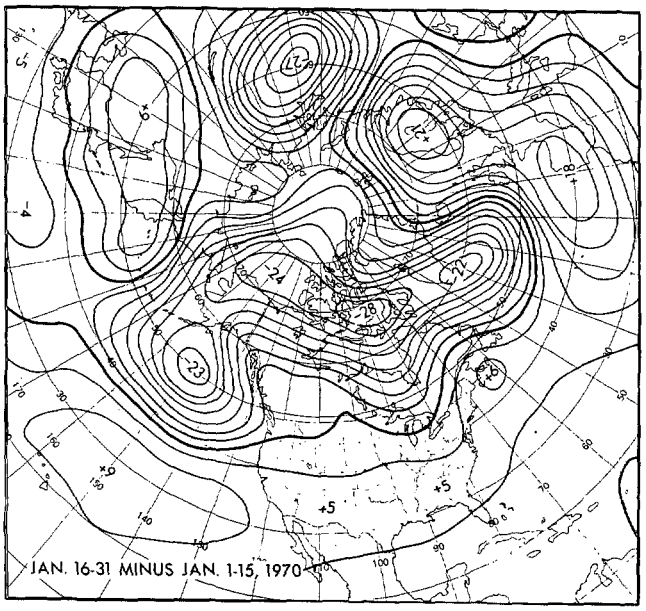


FIGURE 5.—Change in half-monthly mean 700-mb height (decameters) between Jan. 1–15 and Jan. 16–31, 1970.

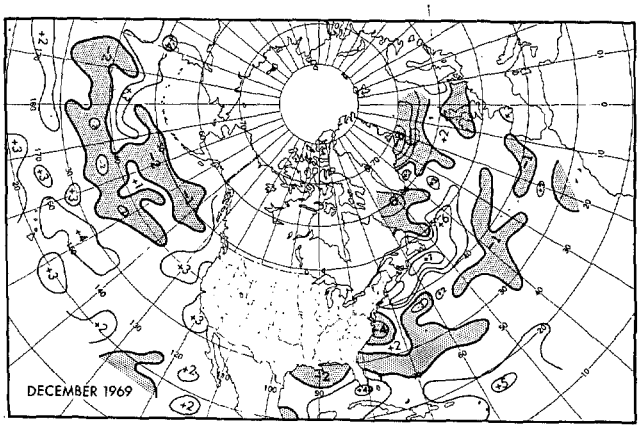


FIGURE 6.—Mean sea surface temperature anomaly (°F) over the eastern Pacific and Atlantic for December 1969 (from Renner 1969 and maps supplied by the U.S. Navy Fleet Weather Central 1969 and the British Meteorological Office 1969). Analysis is at intervals of 2°F, and below-normal areas are shaded.

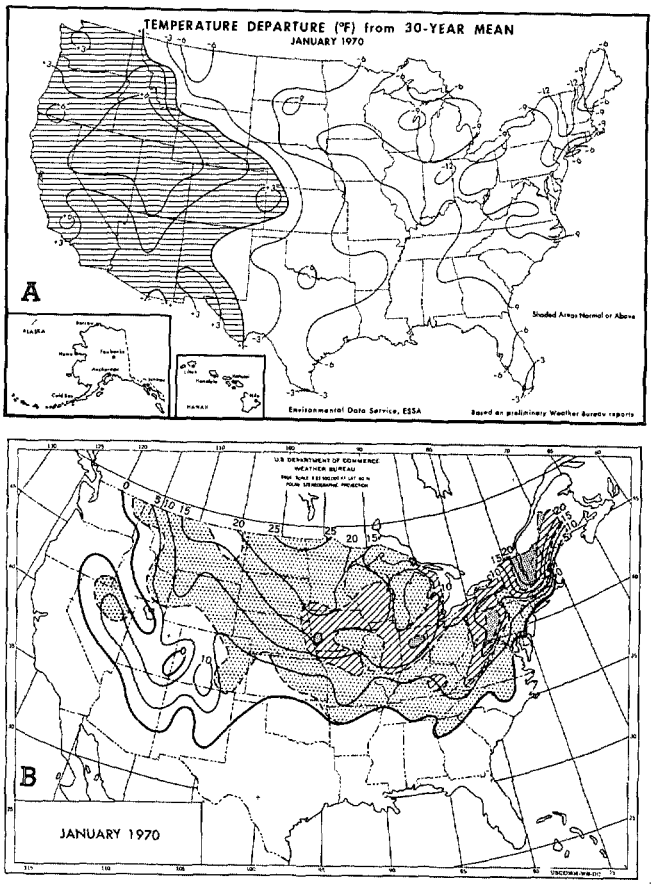


FIGURE 7.—(A) departure from normal of average surface temperature for January 1970 (from Environmental Data Service 1970); (B) number of days with minimum temperatures of 0°F or below (numbered solid lines) and excess of this number over normal (shaded areas) for January 1970. Large dots show areas with 0 to 5 days; diagonal lines, areas with 5 to 10 days; and fine dot shading, areas where the temperature fell to 0°F or below on 10 or more days in excess of the normal number.

flow extending from near Hawaii to the west coast, which advected mild subtropical air masses into the West (figs. 1 and 2).

More than a dozen stations in the East either established or came close to establishing new January mean low temperatures (table 1). The most extreme cold was in the Northeast, where January 1970 was the coldest month in history at Concord, N.H., Burlington, Vt., and Albany, N.Y.—all stations with records going back into the 19th century.

Nearly half the area of the conterminous United States had greater than the normal number of days with minimum temperatures at or below 0°F (fig. 7B). The greatest excess of subzero cold days was also in the Northeast. Burlington, Vt., had 24 days with minimum temperatures of 0°F or below, the same as International Falls, Minn., but 14 days more than normal. Sections of the central Appalachians and Midwest had 5 or more days in excess of the normal number, with minima of 0°F or below. Many stations in these areas reported a record number of days with minima at or below 0°F during January 1970.

The extreme cold weather may be described in several other ways. Many stations in the Atlantic States and Midwest set daily record low minima on 6 or more days during January. At Erie, Pa., the total of six new record low daily minimum temperatures was the most set in any month since records began in 1873.

At several stations, the persistent cold in January, which continued from the latter part of December, established new records for duration of temperatures failing to rise above the freezing mark. Some of the record freezing spells were 44 days at Burlington, Vt., 42 days at Madison, Wis., and 47 days at Houghton Lake, Mich. Huron, S. Dak., had its second longest subfreezing period of record (30 days), and the cold at Boston, Mass., came within a few hours of the longest recorded subfreezing spell there.

Only in the Far West were any records for warmth established, as tropical air from the Pacific Ocean frequently entered the region, especially during the latter half of the month. Most were daily records, although Medford, Oreg., and Sacramento, Calif., recorded their second warmest January in history.

TABLE 1.—*Record and near-record monthly mean temperatures established during January 1970*

Station	Temperature (°F)	Departure from normal (°F)	Remarks
Concord, N.H.	11.0	−10.2	Coldest month on record
Burlington, Vt.	3.6	−12.6	Coldest month on record
Albany, N.Y.	9.7	−13.0	Coldest month on record
Providence, R.I.	19.6	− 9.6	Coldest January and 2d coldest month on record
Hartford, Conn.	16.8	− 9.2	Coldest January and 2d coldest month on record
Wilmington, Del.	24.5	− 8.9	3d coldest January on record
Elkins, W. Va.	20.2	−12.5	2d coldest January on record
Beckley, W. Va.	24.0	− 9.6	Coldest January on record
Avoca, Pa.	17.7	−10.0	2d coldest January on record
Allentown, Pa.	19.2	− 9.8	Coldest Januray on record
Harrisburg, Pa.	22.9	− 8.4	2d coldest January on record
Erie, Pa.	16.8	−10.5	3d coldest January on record
Youngstown, Ohio	17.8	− 9.5	2d coldest January on record
Cleveland, Ohio	18.8	− 9.6	Tied for 2d coldest January on record
Detroit, Mich.	16.6	− 9.6	2d coldest January on record
Chattanooga, Tenn.	32.0	− 9.7	3d coldest January on record
West Palm Beach, Fla.	60.4	− 6.5	2d coldest January on record
Tampa, Fla.	54.0	− 7.2	2d coldest January on record
Lakeland, Fla.	54.3	− 7.4	3d coldest January on record
Medford, Oreg.	42.5	+ 7.1	2d warmest January on record
Sacramento, Calif.	51.7	+ 5.3	2d warmest January on record

3. PRECIPITATION

The precipitation regime over the conterminous United States also was sharply contrasted during January 1970. Heavy amounts fell over the Northwest and parts of the Florida Peninsula. Over 16 in. of precipitation were recorded on the Oregon coast and in portions of the Cascades (fig. 8A), and parts of northern California and most of the northern Great Basin had over twice their normal January totals (fig. 8B). About a dozen stations in Idaho, Washington, Oregon, and northern California reported record or near-record precipitation during the month (table 2).

The Pacific Northwest rains were not only heavy but persistent. Beginning on the 8th and 9th of the month, measurable rain fell for 20 consecutive days at Eureka, Calif., 17 at Red Bluff, Calif., and 16 at Boise, Idaho. The long rainy spells at the latter two cities established new records. Some flooding occurred in northern California toward the end of the month, but it was not of disastrous proportions. Precipitation in southern California was subnormal, in sharp contrast to the flood-producing rains and mudslides of the previous January (Wagner 1969).

Much of the remainder of the Nation was dry, with totals mostly under an inch and less than half normal (figs. 8A and 8B). The Northeast was extremely dry, with several stations reporting only about one-fourth their normal January totals. Records were established at many of these locations (table 2). The extensive dryness was related to the persistent Arctic air masses prevailing throughout most of the month, which along with northerly anomalous flow (fig. 2), prevented any major influxes of moisture from the Gulf of Mexico or the Atlantic. Much of the time, the polar front stayed near Florida, where

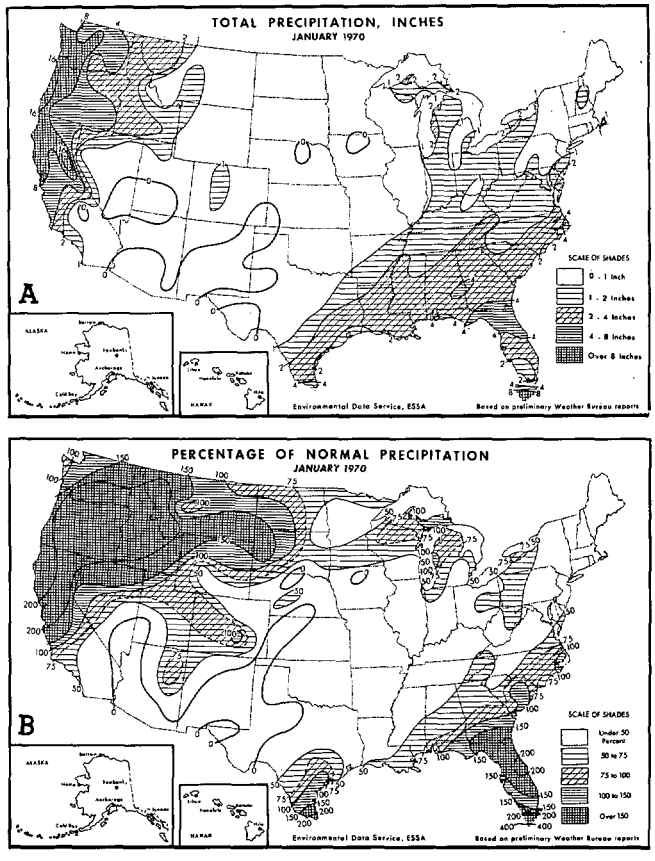


FIGURE 8.—(A) total precipitation (inches) for January 1970 (from Environmental Data Service 1970); (B) percentage of normal precipitation for January 1970 (from Environmental Data Service 1970).

precipitation was above normal and Key West reported the second wettest January on record.

Although water equivalents were not very large due to the extreme coldness of the prevailing Arctic air masses, some areas near the Great Lakes had fairly heavy snows and persistent precipitation. Muskegon, Mich., had a total of 60 in. of snow, the third greatest of record, while at Erie, Pa., January 1970 was the first month of record in which some precipitation fell every day. Nevertheless 11 days had traces, and the monthly total was only about half the normal, due to the absence of any major storms or heavy snow squalls.

4. WEEKLY WEATHER AND CIRCULATION

JANUARY 5–11

During the first few days of the month, a strong ridge over the eastern Pacific drove cold air into most of the West, and the only subzero readings of the month in the Great Basin were reported. By the first full week of the month, cold air had swept over the entire conterminous United States, and progression of the eastern Pacific ridge inland to the Great Basin allowed some warming in California (figs. 9A, 9B). Strong northwesterly flow between the ridge and a deep trough near the east coast brought bitterly cold Arctic air from the Northern Plains through the Midwest deep into the Southeast. Weekly mean temperatures averaged as much as 24°F below normal over Montana and parts of the Midwest, and the zero line

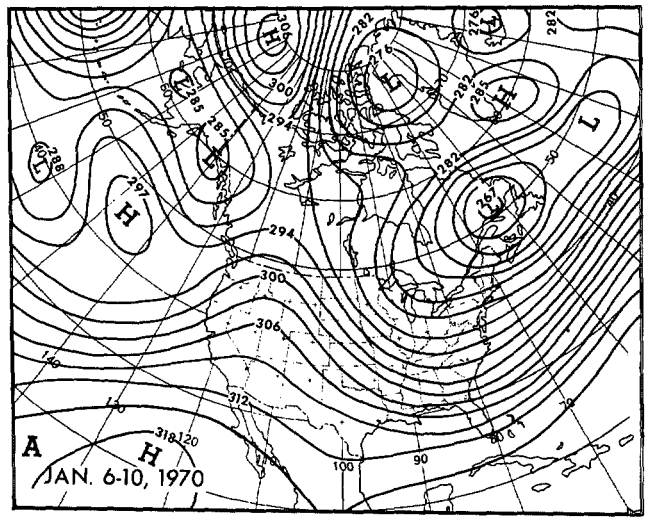
TABLE 2.—*Record and near-record monthly precipitation totals recorded during January 1970*

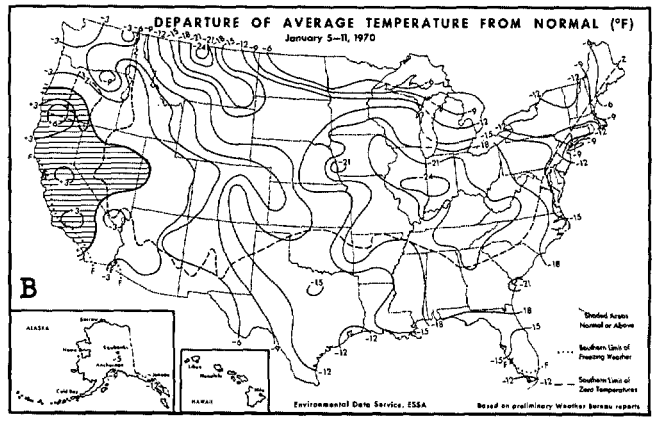
Station	Precipitation (in.) Total	Departure from normal	Remarks
Boise, Idaho	3.87	+ 2.55	Wettest January since 1912
Lewiston, Idaho	3.55	+ 2.44	Wettest January on record
Walla Walla, Wash.	5.86	+ 3.97	Wettest month on record
Yakima, Wash.	3.66	+ 2.47	Wettest January on record
Pendleton, Oreg.	3.92	+ 2.50	Wettest month since 1912, 4th wettest month on record
Portland, Oreg.	15.22	+ 8.88	Wettest January on record
Eugene, Oreg.	14.38	+ 8.05	2d wettest January on record
Salem, Oreg.	13.47	+ 6.77	3d wettest January on record
Sexton Summit, Oreg.	19.03	+13.44	Wettest January on record
Stockton, Calif.	7.06	+ 4.51	Wettest January since 1916
Blue Canyon, Calif.	34.07	+22.37	Wettest January on record
Key West, Fla.	8.20	+ 6.67	2d wettest January on record
Concord, N.H.	0.40	− 2.83	Driest January on record
Boston, Mass.	0.89	− 3.05	Driest January on record
Trenton, N.J.	0.91	− 2.19	3d driest January on record
Avoca, Pa.	0.52	− 1.77	2d driest January on record
Williamsport, Pa.	0.95	− 1.72	Driest January in 20th century
Columbia, Mo.	0.23	− 1.48	3d driest January on record
Norfolk, Nebr.	0.10	− 0.68	2d driest January since 1930
Valentine, Nebr.	0.02	− 0.38	2d driest January on record

plunged to the southern Appalachians.

The cold was so intense that temperatures failed to rise above zero for 2 days in parts of the Midwest and central Appalachians. Maxima of 0°F at Elkins, W. Va., on Jan. 8 and 9 set new marks for the lowest maxima of record. The 9th of January with a mean temperature of −3°F at Beckley, W. Va., was the coldest day on record there. The temperature at Waterloo, Iowa, remained below zero for 135 hr between the 4th and 10th of January, and even in usually warm Florida, the 5-day period from the 7th to the 11th with a mean temperature of only 48°F was the second coldest on record at Miami Beach. Several stations at widely scattered locations in the East broke or tied records for low minima in January or for any month (table 3).

Precipitation was generally light or moderate over most of the Nation, with only parts of the Far West and the Gulf Coast reporting weekly amounts in excess of 2 in. (fig. 9C). The bulk of the precipitation in the Southeast came with a fast-moving wave that moved from the Gulf of Mexico just prior to the onset of the coldest weather.





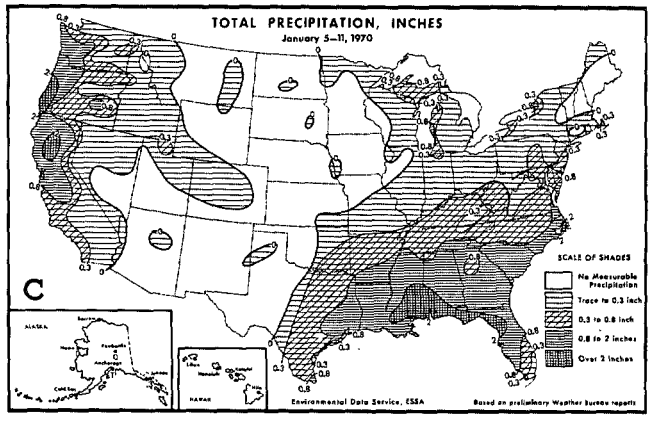


FIGURE 9—(A) mean 700-mb contours (decameters) for Jan. 6–10, 1970; (B) departure from normal of average surface temperature (°F); and (C) total precipitation (inches) for week of Jan. 5–11, 1970 (from Environmental Data Service 1970).

JANUARY 12–18

During this period, the northern portion of the Basin ridge advanced a little further to the Rockies and deepening in the central Pacific increased the flow of mild subtropical air into all areas west of the Divide (figs. 10A, 10B). An unusually intense storm at low latitudes produced damaging winds on the 13th in Hawaii, with gusts up to 80 kt at some exposed locations. As this system moved northeastward, it heralded the onset of the period of mildest weather and heaviest precipitation in the West. Temperatures in the central Great Basin rose to more than 15°F above normal, and rainfall in excess of 2 in. prevailed from the Cascades to the coast, except in extreme southern California (figs. 10B, 10C).

Except for portions of the eastern slopes of the central and southern Rockies, the area east of the Divide remained cold, although temperatures were not quite as far below normal in most areas as they had been the previous week. Moderation to near normal occurred in parts of the Southeast, as the mean 700-mb flow turned to west-southwest (figs. 10A, 10B).

Except for the southern Plains and part of the central Gulf area, most of the country east of the Rockies had light and moderate precipitation totals of less than an inch, as several weak disturbances but no major storms crossed the country (fig. 10C).

TABLE 3.—*Record and near-record daily temperatures observed during January 1970*

Station	Temperature (°F)	Day	Remarks
Del Rio, Tex.	19	7	Equaled alltime low
Augusta, Ga.	5	9	New January record low
Raleigh, N.C.	0	9, 22	New alltime record lows
West Palm Beach, Fla.	29	10	New alltime record low
Tallahassee, Fla.	12	10	Equaled January low
Columbia, S.C.	5	10	New January record low
Minneapolis, Minn.	−34	19	Equaled alltime low
Sioux Falls, S. Dak.	−36	19	2d lowest January reading and 2d coldest since 1912
San Francisco, Calif.	60	21	Tied highest daily minimum ever recorded in January
Sacramento, Calif.	59	22	Highest daily minimum ever recorded in January
Red Bluff, Calif.	58	22	Do.
Elko, Nev.	62	23	New January record high
Salt Lake City, Utah	60	23	Equaled record January high
El Paso, Tex.	80	24	New January record high
Lubbock, Tex.	83	24	New January record high
Norfolk, Va.	78	29	2d highest January temperature and highest in 99 yr

JANUARY 19–25

Amplification of the ridge over the Rockies during the third full week of January, in response to further deepening of the central Pacific trough, strengthened the advection of mild Pacific air into the West and brought renewed Arctic outbreaks into the East (figs. 11A, 11B). Weekly temperature anomalies ranged from more than 21°F above normal along the Idaho-Utah border to more than 21°F below normal over central New England. Record cold was observed in the northern Mississippi Valley and for the second time this month at Raleigh, N.C. (table 3).

The warmest and wettest weather of the month occurred in the West this week. Weekly rainfall totals were in excess of 8 in. along part of the Oregon coast and in the Cascades (fig. 11C). Several stations had 2 in. or more within a 24-hr period. The peak surge of tropical air seemed to cross the west coast on the 21st and 22d, when several stations reported the highest January daily minima of record (table 3).

Deamplification of the flow toward the end of the week allowed the warm air to move into the Plains where daily January maximum records were established in western Texas. The eastward movement of the mild Pacific air, warmed further by subsidence as it crossed the Rockies, brought an end to the long siege of cold in the middle of the country. Within a few days, temperatures rose from 10° to 20°F below normal to 10° to 20°F above normal, dividing the month into two sharply contrasting temperature regimes. At Omaha, Nebr., the first 21 days of January averaged 15.1°F below normal, while the last 10 days averaged 12.3°F above.

JANUARY 26–FEBRUARY 1

Rapid deepening of the polar Low just north of Hudson Bay and deamplification of the midlatitude wave train over the Pacific and North America helped spread warmer than normal air over the whole country during the final week of January (figs. 12A, 12B). The central height of

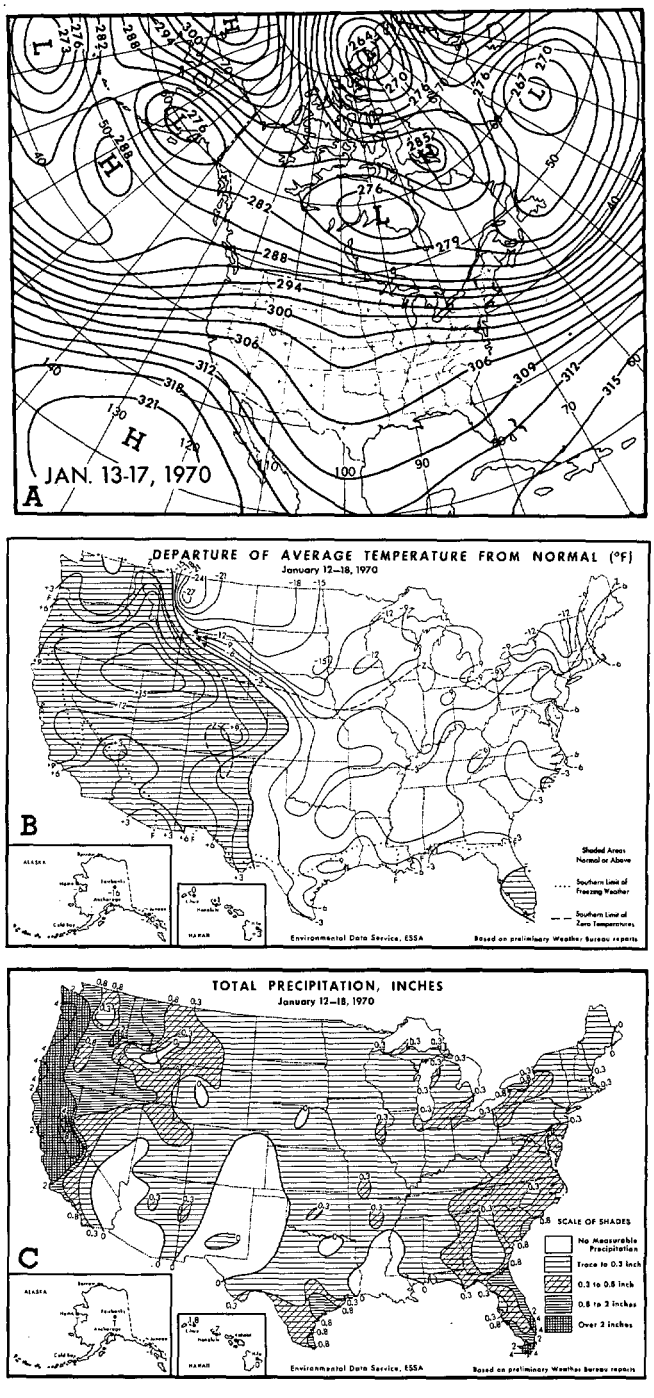


FIGURE 10.—Same as figure 9, (A) for Jan. 13–17, 1970; (B) and (C) for Jan. 12–18, 1970 (from Environmental Data Service 1970).

the intense vortex in Canada was 290 m below normal. It was not until January 29 that the mild air made its way into the Northeast, about a week later than the statistically preferred date of the "January Thaw" (Wahl 1952). A near-record high of 78°F was set on the 30th at Norfolk, Va. (table 3).

Precipitation along the Pacific coast decreased somewhat, although a large area west of the Cascades still had totals of more than 2 in. The trailing cold front of the storm that brought the mild air to the East set off some convective activity in the Southeast, where much of the area reported rainfall of an inch or more for the week (fig. 12C).

During the final days of the month, a large cool High

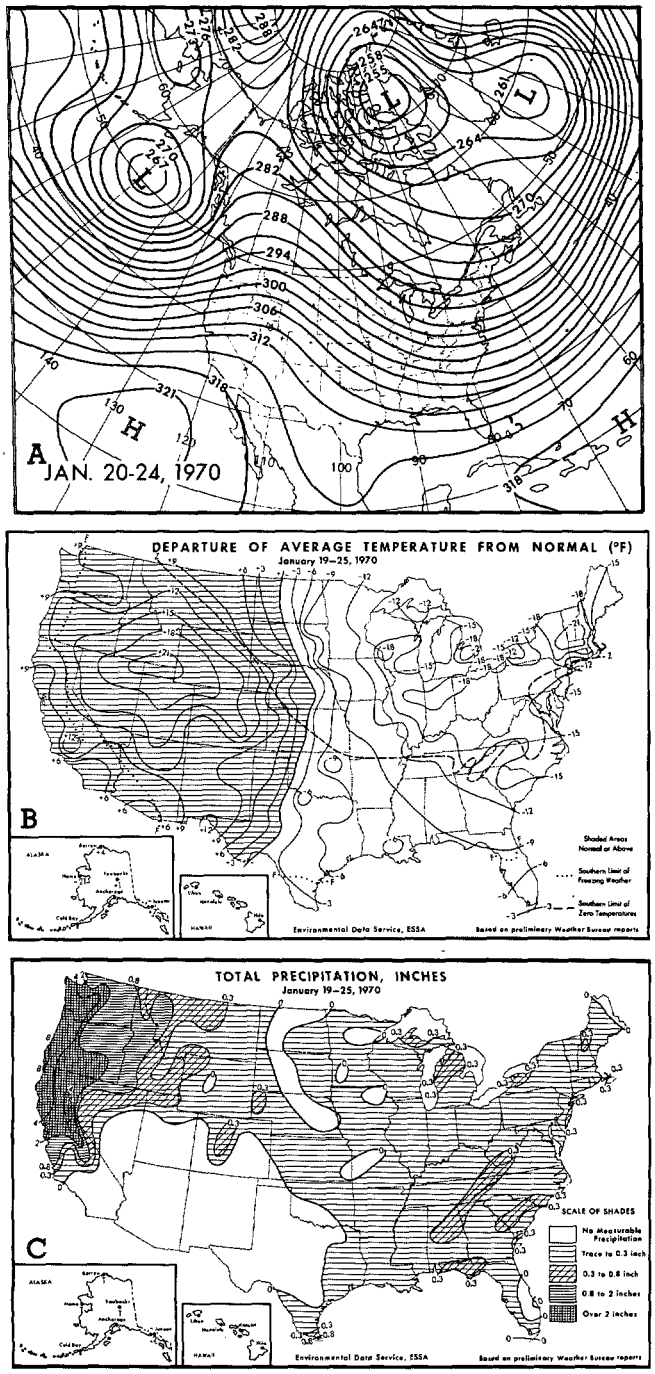


FIGURE 11.—Same as figure 9. (A) for Jan. 20–24, 1970; (B) and (C) for Jan. 19–25, 1970 (from Environmental Data Service 1970).

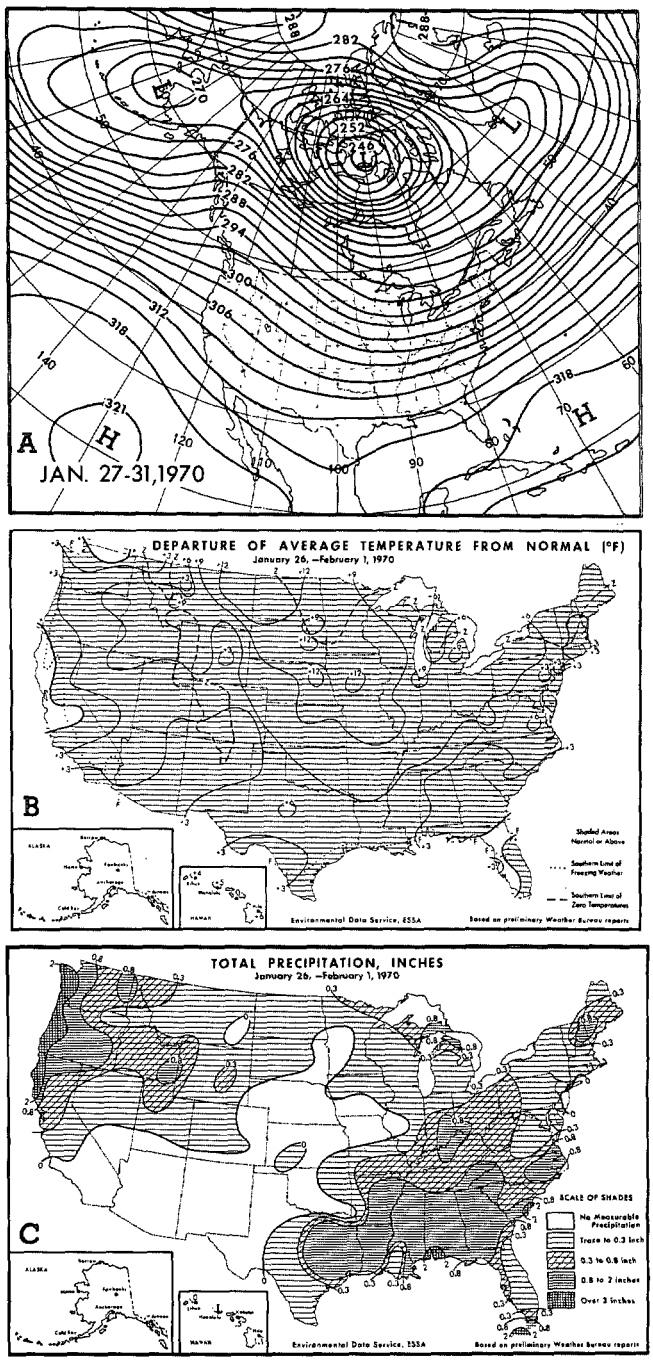


FIGURE 12.—Same as figure 9, (A) for Jan. 27–31, 1970; (B) and (C) for Jan. 26–Feb. 1, 1970 (from Environmental Data Service 1970).

moved across the Nation from the Northern Rockies to the South; but since it was of Pacific origin, temperatures were moderate and seemed all the more so in comparison to the bitter cold observed earlier in the month.

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